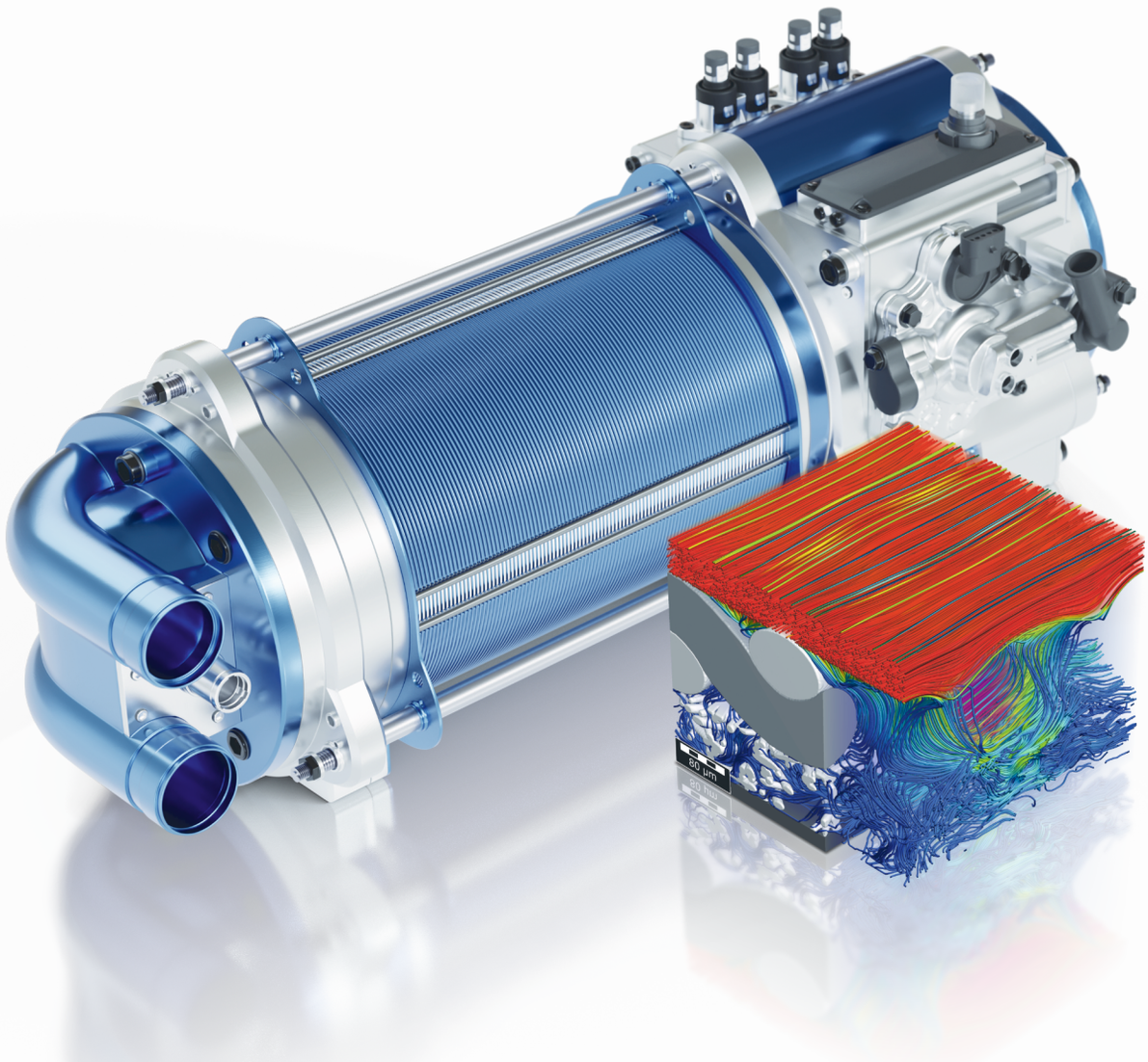
GeoDict

The Digital Material Laboratory

Fuel Cells



The Motivation

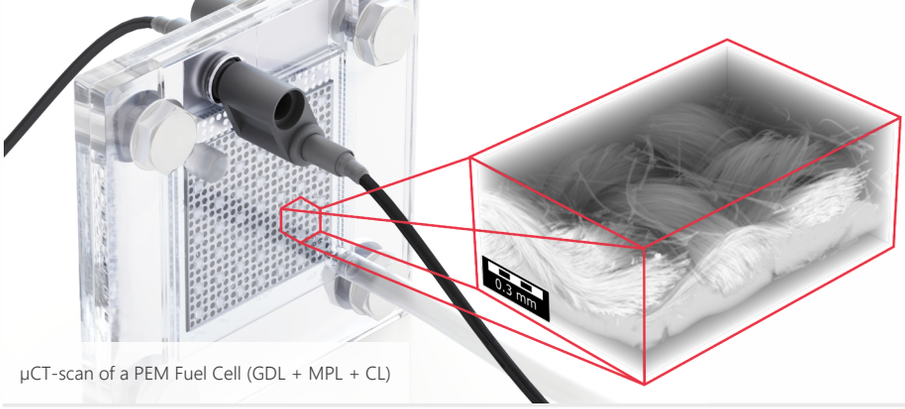
Fuel cells are part of the solution towards a sustainable future. By harnessing the power of hydrogen, they provide clean and efficient energy that leaves no harmful emissions behind. With their versatility and reliability, fuel cells have the potential to revolutionize the way we power our homes, businesses, and vehicles. Don't just imagine a world without dependency on fossil fuels, make it a reality with fuel cells.

Our Solution

GeoDict digitally generates realistic 3D models of the microstructure of materials used in electrolyzers and fuel cells – the PEM, GDL, MPL, and the CL. Then the critical material properties for the performance of these models are characterized. The goal of the simulations is to optimize the microstructure of each component to improve the performance of the energy materials.

Your Benefit

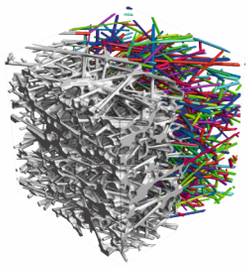
Transform your fuel cell material research and development with GeoDict. Save time and money with simulations. Gain valuable insights into the inner workings of fuel cell materials that laboratory experiments cannot provide. Complement your experiments and directly identify and correct any weaknesses. Optimize your research by including simulations.



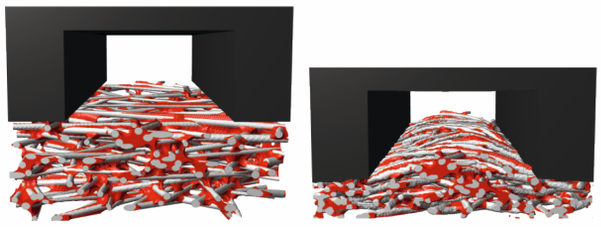
µCT-scan of a PEM Fuel Cell (GDL + MPL + CL)

Digitalization

Import a 3D scan of the microstructure of membrane electrode assembly components (MEA). Image filters and AI tools help to segment and create structures of real 3D models of the electrodes including multi scale approaches.



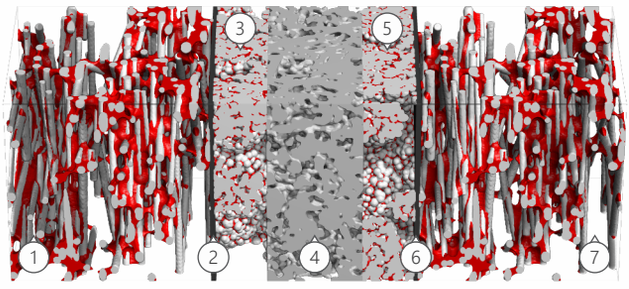
FiberFind fiber identification



A compression of the GDL by 30 % leads e.g. to a 40 % drop in permeability

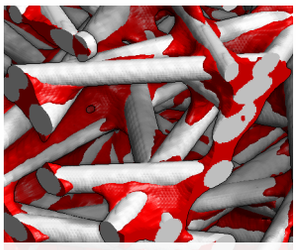
Material Analysis

Characterize materials based on the segmented scan. Calculate tortuosities, diffusivities and conductivities of structural modifications. Digitally reproduce the compression of the GDL using powerful solvers.

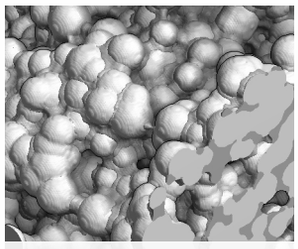


Generated PEM Fuel Cell

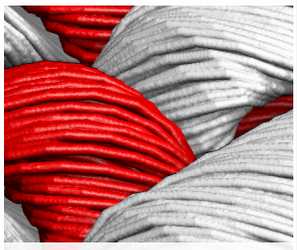
1 **G**as **D**iffusion **L**ayer Cathode
2 **M**icro**p**orous **L**ayer
3 **C**atalyst **L**ayer
4 **P**olymer **E**lectrolyte **M**embrane
5 **C**atalyst **L**ayer
6 **M**icro**p**orous **L**ayer
7 **G**as **D**iffusion **L**ayer Anode



FiberGeo module



GrainGeo module



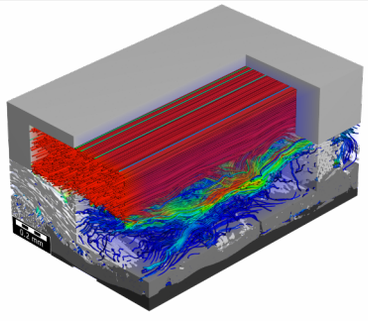
WeaveGeo module

Microstructure Design

Generate three-dimensional models of fibrous and granular structures representing porous transport layers and catalyst layers. Use structure generation to add non-visible phases in 3D scan data. For cutting-edge materials, GeoDict provides a variety of options to customize the models.

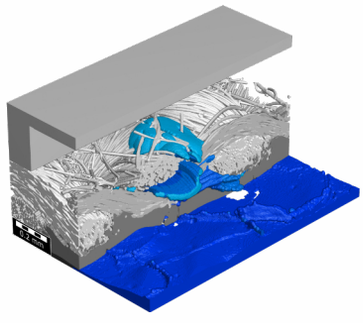
Characterize:

- Capillary pressure curves
- Relative permeabilities
- Large deformation
- Strain/Stress Curve
- Conductivity



Analyze:

- Particle tracking
- Porosity
- Pore size distribution
- Fiber and particle orientation
- Tortuosity and Gurley value



Property Prediction

After designing the microstructure, optimize its properties. Obtain the capillary pressure curve of materials or track the particles in the gas flow. Simulate large deformations and understand where the material parameters need to be optimized. Improve the microstructure with the calculated properties.

Math2Market GmbH | Richard-Wagner-Str. 1 | 67655 Kaiserslautern, Germany
☎ +49 631 205 605 0 +49 631 205 605 99 electrochemistry@math2market.de
www.GeoDict.com

MATH 2 MARKET